

Colony Densities and Preferences for Nest Habitats of Some Social Wasps in Mato Grosso State, Brazil (Hymenoptera, Vespidae)

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Abstract.—Studies of colony densities and preferences for nest habitats of some social wasps were conducted in cerrado vegetation in Southern Mato Grosso state in Central Brazil. Wasp colony densities were estimated in three habitats (campo úmido, cerrado *sensu-stricto* and gallery forest). Regarding the wasp nest habitats preferences, we found 100 colonies of 30 species in 15 genera nesting in six different habitats in Southern Mato Grosso. In Northern Mato Grosso, based on Richards (1978), we found 199 colonies of 51 species in 14 genera nesting in six different habitats. Considering both regions together, we came out with 299 colonies of 61 species in 16 genera nesting in nine different habitats.

INTRODUCTION

The effectiveness and efficacy of predation by social wasps on many insects (Gobbi *et al.* 1984, Gobbi and Machado 1985, Machado *et al.* 1987, Raw 1988) confers on them a fundamental importance as biological control agents. Nonetheless, the study of the nests of these insects has focused mainly on their architecture (Jeanne 1975, Kojima 1982) and on the numbers of individuals per colony (Richards 1978), with few reports on pairs of species nesting close together (Windsor 1972, Starr 1988).

Information on preferences for nest habitats (Richards 1978, Reed and Vinson 1979, Forsyth 1980) and on colony densities (Rau 1942, Kitayama *et al.* 1989) of neotropical social wasps is still very scarce. In central Brazil, 130 species of wasps have been collected (Richards 1978, Raw pers. comm. and our own collections), but studies on their ecology are very fragmentary.

The aim of this report is to add new information on colony densities and preference for nest habitats of social wasps in the cerrado *sensu-lato* of Central Brazil.

METHODS AND STUDY AREA

The study was conducted in cerrado vegetation during a five week survey (August, October through December 1988 and June 1989) at the Rio Manso Hydroelectric Power Station (HPS-Rio Manso) (14°52' S and 55°50' W), in the Chapada dos Guimarães county, southern Mato Grosso State in central Brazil.

Cerrado *sensu-lato* is a semideciduous xeromorphic vegetation dominant in Central Brazil, occupying about 20% of the whole country. It occurs in various structures from closed forest-like forms to pure grasslands (Eiten 1972). "Habitat" is used here to refer to a vegetation subtype within the cerrado *sensu-lato*.

The censuses of social wasp colonies (nests with resident adults) were conducted in campo úmido, vereda, campo sujo, cerrado *sensu-stricto*, gallery forest and surrounding dirt roads. Characterizing these habitats very briefly it could be said that campo úmido is a wet grassland without visible woody plants (Fig. 1); vereda is a broad marshy valley bottom grassland with buriti palm (*Mauritia vinifera*) galleries (Fig. 2); campo sujo is a cerrado grassland with a few, very scattered, low conspicuous shrubs or acaulescent palms (Fig. 3);



Fig. 1. Area of 100 m² of campo úmido where wasp nests were surveyed.

Fig. 2. Area of Vereda (Photo by Dr. Roberto Cavalcante).



Fig. 3. Area of campo sujo.

Fig. 4. Area of cerrado *sensu-stricto* (Photo by Dr. Roberto Cavalcante).



Fig. 5. Area of gallery forest (Photo by Dr. Roberto Cavalcante).

cerrado *sensu-stricto* includes forms with the total woody plant cover of about 30-40% and with a canopy generally less than seven meters (Fig. 4) and gallery forest is usually a narrow evergreen mesophytic forest following the streams (Fig. 5) (Eiten 1972).

Searches for nests were conducted in four different months, covering two seasons: dry season (June and August) and wet season (October and December) in six habitats. Each habitat received the same intensity of searching during each of these seasons.

From each nest, adult wasps were collected to guarantee identification of the species. All the nests and insects sampled are deposited in the Laboratório de Zoologia, Departamento de Zoologia in the Universidade de Brasília.

The data on Xavantina and Serra do Cachimbo (10°50'S and 51°47'W), in northern Mato Grosso state were compiled from Professor Richards' (1978) species descriptions of nest habitats using only the data where there was no doubt on the location of the nests). Richards' censuses were conducted in campo sujo, dirt roads and clearings, cerrado *sensu-stricto*, Cerradão (the medium tall arboreal form of cerrado with a closed or semi-open canopy with 30-40% tree crown cover, Eiten

1972), gallery forest and dry forest (deciduous and semi deciduous mesophytic forest, Eiten 1972).

For the study on colony density, known areas were sampled, in gallery forest (7500 m²) and in cerrado *sensu-stricto* (10000 m²). Nests were located among leaves, on branches, on the trunks of trees and in holes in tree-trunks and in the ground. Binoculars were used to locate nests in the canopy. In addition, five squares of 100 m² each were surveyed in campo úmido, where nests of wasps were sought among tufts of grasses and sedges (Fig. 1).

The survey for estimates of the density of colonies, within the study area, was done during the wet season. Three people spent approximately 360 hours searching for nests. In each habitat the time spent per square meter was about one person-minute.

For the estimates of density of adult wasps/ha, the number of adults within some of the nests were counted and also, for some species, data from Richards (1978) were compiled.

In each table the habitats, when it was possible, were arranged in order of increasing complexity of structure because this makes it easier to see general patterns in species preferences for habitats.

RESULTS AND DISCUSSION

1. Nesting Habitat Preference of Wasps

A total of 100 colonies, comprising 30 species in 15 genera of wasps were encountered in six different habitats in Chapada dos Guimarães (Table 1). Among them, 18 species nested in only one habitat, nine in two, and three (*Polybia (Myrapetra) ruficeps* Schrottky—a very common species of the region, *Chartergus chartarius* (Olivier) and *Chartegellus communis* Richards) in three habitats (Table 1). Of the species that nested in only one habitat, most were found in cerrado *sensu-stricto* (seven species), in gallery forest (five species) and in campo úmido (four species) (Table 1). Of the 30 species collected in this study, only *Polistes (Epicnemius) pacificus liliaciosus* de Saussure was not collected by Richards (Table 1 and 2). This subspecies has been collected only rarely in central Brazil and, until Richards' 1978 record, its distribution was thought to be restricted in Brazil to the North (Amazonas, Amapá and Pará states). *Polybia ruficeps* was the commonest species of wasp at Rio-Manso with 23 colonies, of which 70% were found in cerrado *sensu-stricto*. Three other species, *Epipona tatus* (Cuvier), *Synoeca surinama* (L) and *Chartergus chartarius*, with eight colonies each, were also common (Table 1).

Richards (1978) recorded 199 colonies comprising 51 species in 14 genera nesting in six habitats (Table 2). Most of the species he collected (25 of the 51), were found nesting only in one habitat (eight of them in dry forest), 12 species nested in two habitats, eight nested in three habitats, three nested in four, and one species *Polybia (Myrapetra) platycephala* Richards nested in five habitats. In Xavantina and Serra do Cachimbo, *Polybia (Myrapetra) occidentalis* (Olivier) with 24 colonies (12%), was the most abundant, followed by *Polybia ruficeps* (10%), *Polybia (Apopolybia) jurinei* de Saussure (8%), *Polybia (Trichothorax) ignobilis* (Haliday) (7%) and *Polybia (Formicicola) rejecta* (F) (5%) (Table 2).

The data collected by us and by Richards were combined and for the same type of habitat the data were lumped (Table 3 representing the sum of Tables 1 and 2). At the nine habitats 299 colonies, comprising 61 species and 16 genera, were collected. Twenty eight species (46%) nested in only one habitat, 13 species nested in two, 10 in three,

seven in four and three in five habitats (Table 3). The area surveyed was different in each habitat so the number of colonies found do not represent one absolute abundance but the relative habitat preference for nesting.

Of the total number of colonies recorded by Richards and us from Mato Grosso, the species with the largest number of colonies was *Polybia ruficeps* (14%), followed by *Polybia occidentalis* (9%), *Polybia jurinei* (6%), *Polybia (Myrapetra) erythrothorax* Richards (5%), *Polybia ignobilis* (5%), *Parachartergus fraternus* (Gribodo) (4%) and *Epipona tatus* (4%). The genus *Polybia* represents 60% of the colonies reported from the two regions of Mato Grosso State (Table 3), ranging from 67% in Xavantina and Serra do Cachimbo (Table 2) to 45% in Rio Manso (Table 1). Among all the colonies of the 19 species of *Polybia* collected, 58% were found in cerrado *sensu-stricto* (Table 3) ranging from 31% in Rio Manso and 55% in Xavantina and Serra do Cachimbo (Tables 1 and 2).

Richards (1978) suggested that the choice of habitat for nesting is very characteristic and less diverse than that used for foraging. His opinion is confirmed in our survey at Rio Manso. For example, both *Synoeca surinama* (L), which nests in gallery forest, and *Polybia (Trichothorax) sericea* (Olivier) in cerrado *sensu-stricto*, were collected when they hunted in gallery forest, cerrado *sensu-stricto*, campo sujo and campo úmido. Of the 30 species of wasps at Rio Manso, 21 (70%) were encountered foraging in more than one habitat (in preparation).

A water source is important for wasps to nest successfully, (Rau 1942, Forsyth 1980). The latter author concluded that the greater colony density of wasps in gallery forest was due mainly to the presence of water. Wet habitats at Rio Manso (gallery forest, eight/ha and campo úmido 60/ha) also had higher colony densities than did dry habitats (cerrado *sensu-stricto* five/ha). *Polistes (Epicnemius) subsericeus* de Saussure and *Mischocyttarus (Mischocyttarus) drewseni* de Saussure which nest in campo úmido, had higher colony density compared to other species in drier habitats, such as cerrado *sensu-stricto*. Availability of water all year round and nest protection by tufts of grasses and sedges, could be the cause of that high density.

Most animals have preferences for particular habitats (Partridge, 1978). In Mato Grosso ap-

Table 1. Wasps nesting habitats in Rio Manso Chapada dos Guimarães: Mato Grosso, Brazil.

Species	CU	VE	CS	OF	CE	GF	TT
<i>Apoica c.f. pallens</i>	0	0	0	0	1	1	2
<i>Brachygastra bilineolata</i>	0	0	0	0	1	0	1
<i>Chartegellus communis</i>	0	1	1	0	1	0	3
<i>Chartergus chartarius</i>	0	0	4	0	3	1	8
<i>Epipona tatua</i>	0	0	0	0	5	3	8
<i>Metapolybia cingulata</i>	0	0	0	0	1	0	1
<i>Mischocyttarus cerberus</i>	0	0	0	0	2	0	2
<i>Mischocyttarus drewseni</i>	2	0	0	0	0	0	2
<i>Mischocyttarus labiatus</i>	0	0	0	0	1	0	1
<i>Mischocyttarus matogrossoensis</i>	1	0	0	0	0	0	1
<i>Mischocyttarus methathoracicus</i>	0	0	0	0	1	0	1
<i>Parachartergus fraternus</i>	0	1	0	0	4	0	5
<i>Polistes canadensis</i>	1	0	0	0	0	0	1
<i>Polistes pacificus</i>	0	0	0	0	0	1	1
<i>Polistes subsericeus</i>	4	0	0	0	0	0	4
<i>Polybia emaciata</i>	0	0	0	0	0	1	1
<i>Polybia erythrothorax</i>	0	0	2	0	4	0	6
<i>Polybia jurinei</i>	0	0	0	0	2	0	2
<i>Polybia occidentalis</i>	0	0	0	1	2	0	3
<i>Polybia paulista</i>	0	0	0	0	0	2	2
<i>Polybia quadricincta</i>	0	0	0	2	0	0	2
<i>Polybia ruficeps</i>	0	0	0	5	16	2	23
<i>Polybia sericea</i>	0	0	0	1	2	0	3
<i>Polybia singularis</i>	0	0	0	0	1	2	3
<i>Protopolybia exigua</i>	0	0	0	1	1	0	2
<i>Pseudochartergus chartergoides</i>	0	0	0	0	0	1	1
<i>Pseudopolybia compressa</i>	0	0	0	0	0	1	1
<i>Pseudopolybia vespiceps</i>	0	0	0	0	1	0	1
<i>Stelopolybia lobipleura</i>	0	0	1	0	0	0	1
<i>Synoeca surinama</i>	0	0	0	2	0	6	8
Total of nests	08	02	08	12	49	21	100
Total of species	04	02	04	06	18	11	30

CU - Campo úmido

VE - Vereda

CS - Campo sujo

OF - Old field

CE - Cerrado *sensu-stricto*

GF - Gallery forest

TT- Total

Table 2. Wasp nesting habitats of Xavantina and Serra do Cachimbo: Mato Grosso, Brazil (Data from Richards, 1978)

Species	CS	DC	CE	CD	GF	DF	TT
<i>Apoica gellida</i>	0	0	0	2	0	1	3
<i>Apoica pallens</i>	0	0	0	0	1	2	3
<i>Brachygastra augustii</i>	0	3	1	3	0	0	7
<i>Brachygastra moebiana</i>	0	0	1	1	0	0	2
<i>Brachygastra scutellaris</i>	0	0	0	0	0	2	2
<i>Chartegellus communis</i>	0	0	1	1	0	0	2
<i>Chartergus chartarius</i>	0	0	1	1	0	0	2
<i>Chartergus metanotalis</i>	0	0	1	0	0	0	1
<i>Clypearia humeralis</i>	0	1	0	0	0	0	1
<i>Epipona tatua</i>	0	1	2	0	0	0	3
<i>Mischocyttarus flavicornis</i>	0	2	0	0	0	0	2
<i>Mischocyttarus latior</i>	0	0	1	0	0	0	1
<i>Mischocyttarus matogrossoensis</i>	1	0	0	0	0	0	1
<i>Mischocyttarus melanoxanthus</i>	0	1	0	0	0	0	1
<i>Mischocyttarus methathoracicus</i>	0	0	0	0	0	1	1
<i>Mischocyttarus omicron</i>	0	1	0	0	0	0	1
<i>Mischocyttarus surinamensis</i>	0	0	0	0	1	0	1
<i>Mischocyttarus undulatus</i>	0	0	0	0	2	0	2
<i>Parachartergus fraternus</i>	0	4	4	0	0	0	8
<i>Polistes billardieri</i>	1	0	0	0	0	0	1
<i>Polistes cinerascens</i>	0	0	1	0	0	0	1
<i>Polistes goeldii</i>	1	0	0	0	0	0	1
<i>Polybia chrysothorax</i>	0	0	2	0	0	0	2
<i>Polybia dimidiata</i>	0	0	0	2	2	2	6
<i>Polybia emaciata</i>	0	0	2	0	0	2	4
<i>Polybia erythrothorax</i>	0	1	2	6	0	0	9
<i>Polybia gorytoides</i>	0	1	0	0	3	0	4
<i>Polybia ignobilis</i>	2	0	7	0	0	5	14
<i>Polybia jurinei</i>	0	0	2	5	6	2	15
<i>Polybia liliacea</i>	0	0	0	1	0	1	2
<i>Polybia micans</i>	0	0	0	0	0	1	1
<i>Polybia occidentalis</i>	11	6	1	6	0	0	24
<i>Polybia platycephala</i>	0	1	1	1	1	2	6
<i>Polybia quadricincta</i>	0	0	0	0	0	2	2
<i>Polybia rejecta</i>	0	0	1	1	2	6	10
<i>Polybia ruficeps</i>	0	6	7	0	7	0	20
<i>Polybia scrobalis</i>	0	0	0	0	2	0	2
<i>Polybia sericea</i>	0	3	1	2	0	0	6
<i>Polybia singularis</i>	0	1	0	3	0	1	5
<i>Polybia striata</i>	0	0	0	0	0	2	2
<i>Protopolybia acutiscutis</i>	0	0	0	0	0	1	1
<i>Protopolybia exigua</i>	1	0	0	0	0	0	1
<i>Protopolybia sedula</i>	0	0	1	0	0	1	2
<i>Pseudopolybia compressa</i>	0	0	0	1	0	0	1
<i>Pseudopolybia vespiceps</i>	0	0	0	1	0	0	1

Species	CU	VE	CS	OF	DC	CE	CD	GF	DF	TT
<i>Polistes cinerascens</i>	0	0	0	0	0	1	0	0	0	1
<i>Polistes goeldii</i>	0	0	1	0	0	0	0	0	0	1
<i>Polistes pacificus</i>	0	0	0	0	0	0	0	1	0	1
<i>Polistes subsericeus</i>	4	0	0	0	0	0	0	0	0	4
<i>Polybia chrysothorax</i>	0	0	0	0	0	2	0	0	0	2
<i>Polybia dimidiata</i>	0	0	0	0	0	0	2	2	2	6
<i>Polybia emaciata</i>	0	0	0	0	0	2	0	1	2	5
<i>Polybia erythrothorax</i>	0	0	2	0	1	6	6	0	0	15
<i>Polybia gorytoides</i>	0	0	0	0	1	0	0	3	0	4
<i>Polybia ignobilis</i>	0	0	2	0	0	7	0	0	5	14
<i>Polybia jurinei</i>	0	0	5	0	0	4	5	6	2	17
<i>Polybia liliacea</i>	0	0	0	0	0	0	1	0	1	2
<i>Polybia micans</i>	0	0	0	0	0	0	0	0	1	1
<i>Polybia occidentalis</i>	0	0	11	1	6	3	6	0	0	27
<i>Polybia paulista</i>	0	0	0	0	0	0	0	0	2	2
<i>Polybia platycephala</i>	0	0	0	0	1	1	1	1	2	6
<i>Polybia quadricincta</i>	0	0	0	2	0	0	0	0	2	4
<i>Polybia rejecta</i>	0	0	0	0	0	1	1	2	6	10
<i>Polybia ruficeps</i>	0	0	0	5	6	23	0	9	0	43
<i>Polybia scrobalis</i>	0	0	0	0	0	0	0	2	0	2
<i>Polybia sericea</i>	0	0	0	1	3	3	2	0	0	9
<i>Polybia singularis</i>	0	0	0	0	1	1	3	2	1	8
<i>Polybia striata</i>	0	0	0	0	0	0	0	0	2	2
<i>Protopolybia acutiscutis</i>	0	0	0	0	0	0	0	0	1	1
<i>Protopolybia exigua</i>	0	0	1	1	0	1	0	0	0	3
<i>Protopolybia sedula</i>	0	0	0	0	0	1	0	0	1	2
<i>Pseudochartergus chartergoides</i>	0	0	0	0	0	0	0	1	0	1
<i>Pseudopolybia compressa</i>	0	0	0	0	0	0	1	0	1	2
<i>Pseudopolybia vespiceps</i>	0	0	0	0	0	1	1	0	0	2
<i>Stelopolybia angulata</i>	0	0	0	0	0	0	1	2	1	4
<i>Stelopolybia fulvofasciata</i>	0	0	0	0	0	0	0	0	1	1
<i>Stelopolybia lobipleura</i>	0	0	1	0	0	1	0	0	0	2
<i>Stelopolybia testacea</i>	0	0	0	0	0	0	0	2	1	3
<i>Synoeca chalybea</i>	0	0	0	0	0	0	2	0	0	2
<i>Synoeca surinama</i>	0	0	0	2	0	0	0	6	1	9
Total of nests	08	02	24	12	32	88	39	48	41	299
Total of species	04	02	10	06	14	29	17	19	23	61

CU—Campo úmido

VE—Vereda

CS—Campo sujo

OF—Old field

DC—Dirt roads and clearings

CE—Cerrado *sensu-stricto*

CD—Cerradão

GF—Gallery forest

DF—Dry forest

TT—Total

Table 4. Wasp colonies density in three different habitats in Rio Manso - Chapada dos Guimarães: Mato Grosso, Brazil.

	Campo úmido	Cerrado <i>sensu stricto</i>	Gallery forest
Area (m ²)	500	10000	7500
Number of nests	3	5	6
Nest density/ha	60	5	8
Density of adult wasps/ha	480	1300	50000
Number of species	2	5	5

proximately 50% of wasps were restricted to a single habitat for nesting (Table 3).

Only a few ubiquitous species like *Polybia occidentalis* (5), *Polybia platycephala* (5), *Polybia (Pedothoeca) singularis* Ducke (5), *Chartergellus communis* (4), *Chartergus chartarius* (4), *Polybia erythrothorax* (4), *Polybia rejecta* (4), *Polybia ruficeps* (4) and *Polybia sericea* (4) use more than three habitats for nesting (Table 3).

Substrates for nesting in the cerrado is almost unlimited (Henriques *et al.* 1992), but availability of food, water and protection could be limiting factors.

2. Density

In an area of 2500 m² of the gallery forest (Fig. 5) three colonies of two species of wasps were found, two of *Polybia (Myrapetra) paulista* H.von Ihering and one of *Polybia ruficeps*. In a contiguous area of approximately 5000 m² three colonies of three species (*Polybia (Pedothoeca) emaciata* Lucas, *Polybia (Myrapetra) sp.* and *Polybia (Pedothoeca) singularis* (Ducke) were found, which correspond to an average of eight colonies and five species per ha (Table 4). In an area of 10000 m² of cerrado *sensu stricto* (Fig. 4), near a stream, three colonies of the following species were found: *Mischocyttarus (Kappa) metathoracicus* (deSaussure), *Mischocyttarus (Mischocyttarus) labiatus* (F) and *Polybia ruficeps*.

Colonies of *Brachygastra bilineolata* Spinola and *Stelopolybia lobipleura* Richards were also found on trees close to each other, but away from the stream with an average of colonies of five species per ha (Table 4). A similar result was found in the cerrado *sensu-stricto* of Brasília DF (Ecological Reserve of IBGE), where six colonies were found in an area of 1.5 ha corresponding to an average of five colonies per ha (Henriques *et al.*, 1992).

In an area of 500 m² of campo úmido (Fig. 1), two colonies of *Polistes subsericeus* and one of *Mischocyttarus drewseni* were found. Based on these numbers estimates were 60 colonies per ha for both species, or 40 per ha for *Polistes subsericeus* and 20 per ha for *Mischocyttarus drewseni* (Table 4). Although the colony density in campo úmido was larger than that found in gallery forest and cerrado *sensu-stricto*, the number of individuals per nest was smaller, due to low numbers of adults per nest (eight per nest). In gallery forest and cerrado *sensu stricto*, the colonies of *Syntoeca surinama*, *Epipona tatua* and *Polybia spp.* were larger, with hundreds to thousands of individuals per nest (Table 4).

In a relatively simply-structured habitat, such as campo úmido (Fig. 1) with a small area (500 m²), the density estimate was more accurate than in more complex habitats. A ranking of habitats in order of reliability of estimate is: campo úmido, cerrado *sensu-stricto* and gallery forest.

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LITERATURE CITED

- Eiten, G. 1972. The Cerrado vegetation of Brazil. *The Botanical Review* 38: 201-341.
- Forsyth, A. 1980. Nest site and Habitat selection by the social wasp, *Metapolybia azteca* Araujo (Hymenoptera: Vespidae) *Brenesia* 17: 157-162.
- Gobbi, N. & Machado, V. L. L. 1985. Material capturado e utilizado na alimentação de *Polybia (Myrapetra) paulista* Ihering 1896 (Hymenoptera-Vespidae). *Anais da Sociedade Entomológica do Brasil* 14(2): 189-195.
- Gobbi, N. Machado, V. L. L. & Tavares Filho, J. A. 1984. Sazonalidade das presas utilizadas na alimentação de *Polybia occidentalis* (Olivier 1791) (Hymenoptera: Vespidae). *Anais da Sociedade Entomológica do Brasil* 13(1): 63-69.
- Henriques, R. P. B. Rocha, I. R. D. & Kitayama, K. 1992. Nest density of some social wasps species in Cerrado vegetation of Central Brazil (Hymenoptera: Vespidae) *Entomologia Generalis* 17(4): 265-268.
- Jeanne, R. L. 1975. The adaptiveness of social wasp architecture. *Quarterly Review of Biology* 50: 267-287.
- Kitayama, K. Rocha, I. R. D. & Bulhões B. M. 1989. Densidade de ninhos de vespídeos em diversos habitats de Mato Grosso. I. *Simpósio Latino-americano sobre Inseto Sociais Neotropicais*. Rio Claro SP. R-67 P 44.
- Kojima, J. I. 1982. Nest architecture of three *Ropalidia* species (Hymenoptera: Vespidae) on Leyte Island, The Philippines. *Biotropica* 14(4): 272-280.
- Machado, V. L. L. Gobbi, N. & Simões, D. 1987. Material capturado na alimentação de *Stelopolybia pallipes* (Olivier 1791) (Hymenoptera: Vespidae) *Anais da Sociedade Entomológica do Brasil* 16 (1): 73-79.
- Partridge, L. 1978. Habitat selection In Behavioural Ecology (Eds. J.R. Krebs & N.B. Davies) Blackwell Scientific Publications, Oxford, 351-376.
- Rau, P. 1942. Habitat preferences of *Polistes* wasps (Hymenoptera: Vespidae) *Entomological News* 53: 293-295.
- Raw, A. 1988. Social wasps (Hymenoptera: Vespidae) and insect pests of crops of the Surui and Cinta Larga Indians in Rondônia, Brazil. *The Entomologist* 107: 104-109.
- Reed, H. C. & Vinson, S. B. 1979. Nesting ecology of paper wasps (*Polistes*) in a Texas urban area (Hymenoptera: Vespidae). *Journal of the Kansas Entomological Society* 52 (4): 673-689.
- Richards, O. W. 1978. The social wasps of the Americas. *British Museum of Natural History*. London 580 pp.
- Starr, C. K. 1988. The nesting association of the social wasps *Mischocyttarus immarginatus* and *Polybia* spp. in Costa Rica. *Biotropica* 20(2): 171-173.
- Windsor, D. M. 1972. Nesting association between two Neotropical polybiine wasps (Hymenoptera: Vespidae) *Biotropica*. 4: 1-3.